# RESEARCH AID

# INPUT FACTORS
# FOR PRODUCTION OF AMMUNITION
# IN THE USSR



CIA/RR RA-10

22 October 1956

# CENTRAL INTELLIGENCE AGENCY

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INPUT FACTORS FOR PRODUCTION OF AMMUNITION IN THE USSR

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(ORR Project 31.487)

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## FOREWORD

The approach used in this research aid is similar to that of CIA/RR 49, <u>Inputs for the Production of Ammunition in the European Satellites</u>, 17 December 1954, SECRET. Because of the lack of specific Soviet input data and the similarity of the processes and products of the US and Soviet ammunition industries, this research aid uses data on US production of ammunition as a basis for calculating Soviet ammunition input requirements. This research aid differs from CIA/RR 49 in that a somewhat different format has been used and the calculations have been refined. In the preparation of this research aid, all calculations have been recomputed from the initial data, and no data have been transferred from CIA/RR 49. Therefore, where any discrepancies occur between this research aid and CIA/RR 49, such as in the gross input factors and inputs of services -- all of which are based upon US practice -- the figures given in this research aid represent revised estimates.

The results are of use in the analysis of materials balances, in the development of use patterns in estimates for the chemicals and metals required, and in the estimates of requirements for consumption in connection with Western export controls.

This research aid has been coordinated on a working level with the Office of the Assistant Chief of Staff, Intelligence, Department of the Army; with the Directorate of Intelligence, Department of the Air Force; and with the Office of Naval Intelligence, Department of the Navy.

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### INPUT FACTORS FOR PRODUCTION OF AMMUNITION IN THE USSR*

Summary


This research aid derives gross input factors and recoverable scrap factors for application to estimates of production of ammunition in the USSR exclusive of underwater ordnance. Ammunition mixes were determined for the Soviet Army, Navy, Air Force, and security troops, based on 1 unit of fire (U/F), or its equivalent, for each weapon in the active units. The total weight of 1 U/F for the Soviet armed forces is estimated at 267,000 short tons.** The requirements of the Soviet Army for 1 U/F amount to 214,000 tons, or 80 percent of this total weight. The Soviet Navy accounts for about 8 percent; the Soviet Air Force including naval aviation, for about 7 percent; and the security troops, for almost 5 percent of the total Soviet requirements for ammunition.

The ammunition mixes were collated into a total mix and divided into seven categories of weapons according to the physical characteristics of the various rounds. The gross inputs and recoverable scrap in the production of each category and of the total were then derived by the use of comparable US factors.

Estimated input factors for the total ammunition mix are summarized in Table 1*** in terms of 1,000 tons of production of such a mix.

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* The estimates and conclusions contained in this research aid represent the best judgment of ORR as of 15 August 1956.
** Tonnages throughout this research aid are given in short tons.
*** Table 1 follows on p. 2.


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Table 1

Estimated Input Factors of Materials and Services and Scrap Recovered
in Production of 1,000 Short Tons of Ammunition in the USSR a/

| Materials or Service | Unit of Measurement | Input Factors per 1,000 Short Tons of Aggregate Ammunition Mix | Recoverable Scrap per 1,000 Short Tons of Aggregate Ammunition Mix |
|---|---|---|---|
| Cast iron | Short tons | 96 | 36 |
| Carbon steel and alloy steel b/ | Short tons | 930 | 350 |
| Copper c/ | Short tons | 320 d/ | 150 d/ |
| Zinc e/ | Short tons | 110 d/ | 52 d/ |
| Lead | Short tons | 23 | |
| Propellants | Short tons | 130 | |
| Explosives | Short tons | 100 | |
| Manpower f/ (loading, assembling, and packing only) | Man-years | 13 g/ | |
| Electric power (loading, assembling, and packing only) | Thousand kilowatt-hours | 200 h/ | |
| Coal as alternate fuel (loading, assembling, and packing only) | Short tons | 95 i/ | |
| Oil as alternate fuel (loading, assembling, and packing only) | Short tons | 55 i/ | |
| Natural gas as alternate fuel (loading, assembling, and packing only) | Short tons | 50 k/ | |
| Lumber for packing | Thousand board-feet | 240 l/ | |
| Steel for packing | Short tons | 21 l/ | |

a. Exclusive of underwater ordnance. All data are rounded to two significant figures.
b. Finished steel.
c. Includes the 70 percent copper content in brass items such as cartridge cases.
d. Excludes the re-use of approximately 70 percent of fired cartridge cases, the remelting of the remaining 30 percent, and the possible extensive substitution of steel for brass.
e. Thirty percent zinc content of brass items.
f. Direct labor.
g. Manpower for the manufacture of metal parts might be 8 to 12 times as much.
h. Electric power for the manufacture of metal parts might be several times as much.
i. Fuels for the manufacture of metal parts might be 8 to 14 times as much at an average value of 10,450 British thermal units (Btu) per pound.
j. Fuels for the manufacture of metal parts might be 8 to 14 times as much at an average value of 18,000 Btu per pound.
k. Fuels for the manufacture of metal parts might be 8 to 14 times as much at an average value of 39.9 million Btu per short ton.
l. Excludes repeated re-use of boxes and containers.

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## I.  Introduction.

The purpose of this research aid is to develop input factors per 1,000 tons of ammunition by which materials and services consumed in production of ammunition in the USSR can be estimated for a given tonnage of an ammunition aggregate.

Information from the USSR about the materials and services required to produce Soviet ammunition is practically nonexistent.  Consequently, it is necessary to approach the problem through the utilization of the considerable body of information available on the types and quantities of ammunition required by the Soviet armed forces.  The types and quantities of ammunition required, in the proper proportion to each other, constitute an ammunition mix which can be analyzed round by round to determine the component materials, both qualitatively and quantitatively.  By the application of industrial factors for losses of scrap, for manpower, and for consumption of electric power and fuel to the ammunition mix, the materials and services required can be estimated.  The industrial factors are taken from US practice but are considered to be applicable to the Soviet ammunition industry because of similarities in Soviet and US industrial practices in the ammunition industry.  One important difference between Soviet and US practices may occur when steel is substituted for brass in the event of a shortage of copper.

Although this method constitutes an indirect approach to the problem, it is a practical technique which produces reasonable results, particularly when unit inputs are applied to large aggregate amounts of ammunition such as annual estimates of production of stockpiles.*

Future information on the Soviet order of battle may reveal new weapons in sizable quantities.  A practical, but minor, limitation to the method used in this research aid may result when the initial requirements of these new weapons for ammunition to be stockpiled are entered into the calculations.

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* For the methodology, see Appendix A.

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## II. Ammunition Mixes.

### A. Soviet Armed Forces.

The Soviet armed forces are made up of the army, the security troops, the navy (which includes the fleet, the coast defense artillery, the naval infantry battalions, and naval aviation), and the air force.

Each of the armed forces requires an ammunition mix suitable to the types and quantities of weapons that are included in its Tables of Organization and Equipment (T/O and E). The following paragraphs brief-ly describe the ammunition mix for each of the armed forces.

#### 1. Soviet Army.

The ammunition mix for the Soviet Army is based upon the unit of fire (U/F), a unit of measure for the supply of ammunition. This measure represents a specified number of rounds per weapon -- a nominal supply of ammunition for 1 day -- which varies with the type, caliber, and individual rate of consumption of a weapon. For example, the U/F for a Soviet 152-millimeter (mm) howitzer is 40 rounds, and the U/F for a 7.62-mm heavy machinegun is 2,500 rounds. A Soviet rifle division usually carries 0.5 U/F with each weapon, 0.5 U/F in the reg-imental combat train for the same weapons, and an additional 0.5 U/F in the divisional combat train -- a total of 1.5 U/F per weapon. In actual practice, consumption may run as high as 2 U/F per day in com-bat and as low as 0.2 U/F per year in peacetime training. 1/*

When totaled on a national level, the U/F for all weapons in the active military units represents an ammunition mix in which the amounts, kinds, and sizes of ammunition indicate the expected relative requirements by the armed services for each type of ammunition. On the basis of the T/O and E of the Soviet Army, an estimate was made of the number and types of weapons in the 175 standing line divisions and in the supporting and antiaircraft units. 2/ When the weights per round 3/ and the U/F for each weapon 4/ are multiplied by the number of weapons in each category, the estimated weights shown in Table 2** are obtained.

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* For serially numbered source references, see Appendix C.
** Table 2 follows on p. 5.

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Table 2

Estimated Weight of 1 Unit of Fire for the Soviet Army
Based on 175 Line Divisions
with Supporting and Antiaircraft Units

| | Short Tons |
|---|---|
| Weapon | Weight |
| 203-mm a/ gun-howitzer | 2,550 |
| 152-mm gun-howitzer and self-propelled gun | 4,510 |
| 152-mm howitzer | 7,170 |
| 122-mm gun | 14,500 |
| 122-mm howitzer | 24,400 |
| 100-mm gun | 52,300 |
| 76.2- and 85-mm gun | 42,000 |
| 57-mm gun | 9,290 |
| 37-mm antiaircraft gun | 1,860 |
| 160- and 240-mm mortar | 4,240 |
| 120-mm mortar | 6,510 |
| 82-mm mortar | 3,550 |
| 132- and 300-mm rockets | 2,410 |
| 107-mm recoilless projectiles | 2,600 |
| SPG-82 antitank projectiles | 426 |
| RPG-2 antitank projectiles | 513 |
| 12.7- and 14.5-mm machinegun | 11,000 |
| 7.62- and 9-mm small arms | 16,500 |
| Antitank and antitransport mines | 1,740 |
| Antitank grenades | 330 |
| Hand grenades | 5,800 |
| Total | 214,000 b/ |

a.  Millimeter.
b.  Rounded.

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## 2. Soviet Security Troops.

The T/O and E of the Soviet security troops is not well known except that about 150,000 of these troops are border guards who are equipped like infantry and that about 250,000 of them are interior troops (MVD) who are similarly equipped but have motorized and mechanized elements. 5/ The 150,000 border guards have been equated on a basis of the number of men per standard company with 580 army infantry companies in order to establish a synthetic T/O and E. Of the interior troops, 50 percent were assigned to rifle regiments, 25 percent to motorized regiments, and 25 percent to mechanized regiments (because these units have a few tanks and artillery pieces). For the purposes of this research aid, the 250,000 interior troops equal -- on the basis of the number of men per standard regiment -- 35 rifle regiments, 29 motorized regiments, and 25 mechanized regiments.

Table 3* shows the estimated weight of 1 U/F for 400,000 Soviet security troops.

## 3. Soviet Naval Fleet.**

Navies do not operate logistically on a U/F basis as do armies. The naval unit of measure for the supply of ammunition is the allowance of ammunition for a ship. The allowance of ammunition depends on the capacities of a ship's magazines and ready-boxes. Ships of similar classes will have similar allowances. A naval unit of ammunition tonnage corresponding to the army U/F tonnage has been established in this report as one-sixth of an allowance for each known combat and auxiliary armed vessel in the Soviet Navy.*** 6/ Although it is possible that this estimate may be high, naval ammunition constitutes less than 2 percent of the total requirements for ammunition, and an overstatement would result in little or no change of input factors.

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* Table 3 follows on p. 7.
** Exclusive of underwater ordnance.
*** One-sixth of an allowance is considered as equal to an army U/F in this research aid because test calculations on ammunition allotted to certain navy guns, as compared with that allotted to somewhat similar army guns, indicated that the navy allowance per gun averages 6 times the army U/F per gun. This ratio is reasonable when it is considered that a ship must expect to maintain itself without means of resupply for weeks, as compared with days for an army unit.

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Table 3

Estimated Weight of 1 Unit of Fire
for 400,000 Soviet Security Troops

| | Short Tons |
|---|---|
| Weapon | Weight |
| 85-mm a/ tank gun | 1,220 |
| 85-mm antitank gun | 1,590 |
| 76-mm self-propelled gun | 271 |
| 57-mm gun | 2,610 |
| 120-mm mortar | 457 |
| 82-mm mortar | 1,290 |
| SPG-82 antitank projectiles | 97 |
| RPG-2 antitank projectiles | 153 |
| 12.7-mm machinegun | 1,210 |
| 7.62-mm machinegun and rifle | 1,440 |
| 7.62-mm submachinegun and pistol | 278 |
| Antitank grenades | 104 |
| Hand grenades | 1,000 |
| Land mines | 564 |
| Total | 12,300 b/ |

a.  Millimeter.
b.  Rounded.

Because the Soviet Navy still has many old naval pieces
of foreign and Tsarist manufacture, there is a large assortment of
calibers among its weapons.

Table 4* shows the estimated weight of 1 equivalent U/F
for the Soviet naval fleet. 7/

* Table 4 follows on p. 8.

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Table 4

Estimated Weight of 1 Equivalent Unit of Fire
for the Soviet Naval Fleet

| | Short Tons |
|---|---|
| Weapon | Weight |
| 12.6-inch Italian gun | 218 |
| 12-inch Tsarist gun | 390 |
| 10-inch Bofors gun | 123 |
| 7.1-inch Soviet gun | 215 |
| 6-inch Soviet and Italian guns | 520 |
| 5.9-inch German gun | 40.8 |
| 5.1-inch Soviet and Tsarist guns | 450 |
| 5-inch German gun | 10 |
| 4.7-inch Tsarist and Italian guns | 111 |
| 4.1-inch Bofors and German guns | 61.8 |
| 4-inch Tsarist gun | 14.6 |
| 3.9-inch Soviet dual-purpose gun | 803 |
| 3.5-inch German gun | 139 |
| 3-inch Soviet and US dual-purpose guns | 175 |
| 57-mm a/ Soviet antiaircraft gun | 66.7 |
| 45-mm Soviet gun | 258 |
| 37-mm Soviet antiaircraft gun | 1,000 |
| 20-mm Soviet antiaircraft gun | 86.5 |
| 12.7-mm Soviet antiaircraft machinegun | 81 |
| Total | 4,760 b/ |

a. Millimeter.
b. Rounded.

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### 4. Soviet Coast Defense Artillery.

In the USSR the defense of the coast against both surface and air attack is the responsibility of the navy, and the system of coast defense is extensive. 8/ One-sixth of a ship's allowance for each particular size of gun in the Soviet coast defense artillery has been allocated as an equivalent U/F, as explained in 3, above.

Table 5* shows the estimated weight of 1 equivalent U/F for the Soviet coast defense artillery.

### 5. Soviet Naval Infantry.

The Soviet naval infantry is organized into battalions and sometimes into brigades of the size of regimental combat teams. The principal task of the naval infantry, which is an element of the coast defense, is to defend naval installations and certain sectors of the coast in which the Soviet Navy has an interest. 9/

Table 6** shows the estimated weight of 1 U/F for the naval infantry. 10/

### 6. Soviet Naval Aviation.

The ammunition mix for Soviet naval aviation has been included in that of the Soviet Air Force, a description of which follows.

### 7. Soviet Air Force.

Because the Soviet Air Force does not use an ammunition unit comparable to an army U/F or a naval ship's allowance, for the purposes of this research aid, 1 load of bombs and ammunition for each combat plane in the Soviet Air Force (including naval aviation) is considered the equivalent of 1 U/F. This equivalent U/F will compare with the quantity of ammunition carried by the army with each weapon combined with what is carried in the regimental train.

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\* Table 5 follows on p. 10.
\*\* Table 6 follows on p. 10.

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Table 5

Estimated Weight of 1 Equivalent Unit of Fire
for the Soviet Coast Defense Artillery

| | Short Tons |
|---|---|
| Weapon | Weight |
| 14-inch naval gun | 273 |
| 12-inch naval gun | 1,560 |
| 7.1-inch naval gun | 1,340 |
| 6-inch naval gun | 2,980 |
| 5.1-inch naval gun | 2,550 |
| 3.9-inch dual-purpose gun | 2,310 |
| 3-inch dual-purpose gun | 1,310 |
| 57-mm a/ antiaircraft gun | 2,780 |
| 37-mm antiaircraft gun | 646 |
| Total | 15,700 b/ |

a. Millimeter.    b. Rounded.

Table 6

Estimated Weight of 1 Unit of Fire
for the Soviet Naval Infantry

| | Short Tons |
|---|---|
| Weapon | Weight |
| 82-mm a/ mortar | 112 |
| SPG-82 antitank projectiles | 39.7 |
| 7.62-mm machinegun and rifle | 98.2 |
| 7.62-mm submachinegun and pistol | 41.3 |
| Hand grenades | 184 |
| Total | 475 b/ |

a. Millimeter.    b. Rounded.

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Table 7* shows the estimated weight of 1 equivalent U/F for the Soviet Air Force. 11/ The method employed yields a figure which appears high, but this figure is only 7 percent of the over-all weight and would not affect the input factors to any great extent.

B. Relative Requirements for Ammunition According to Component of the Armed Forces.

Table 8** summarizes the ammunition mixes previously given and shows the relative requirements for ammunition in the various components of the armed forces in the order of their importance. The most reliable information from which these ammunition mixes have been computed concerns the army, which is the largest consumer of ammunition, requiring 80 percent of the total.

III. Inputs for Production of Ammunition.

A. Inputs of Materials.

The Soviet ammunition industry is considered in this research aid to comprise those plants and shops which form, load, assemble, and pack the metal parts of ammunition. These installations receive metallic materials from mills and foundries in the shape of pigs, billets, bars, plates, sheets, rods, wire, tubing, and pipe. Scrap metal is considered an output of the ammunition industry but an input back to the mills and foundries or to the scrap metal industry, less the loss in re-melting. Propellants and explosives are considered to be received, ready for use, from the explosives or the chemical industry. Lumber is considered to be received as sawn wood ready to be made into packing boxes.

1. Component Materials.

The most important materials used in production of ammunition are cast iron, carbon steel, alloy steel, brass, copper, lead, propellants, explosives, and packing lumber. Cast iron and carbon steel are used in projectiles for fragmentation, and carbon steel is also used in fuses and for a few types of cartridge cases. Alloy steel is

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* Table 7 follows on p. 12.
** Table 8 follows on p. 12.

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Table 7

Estimated Weight of 1 Equivalent Unit of Fire
for the Soviet Air Force (Including Naval Aviation)

Short Tons

| Weapon | Weight |
|---|---|
| 37-mm a/ aircraft gun | 560 |
| 23-mm aircraft gun | 1,840 |
| 12.7-mm aircraft machinegun | 148 |
| 7.62-mm aircraft machinegun | 40.2 |
| General-purpose or demolition bombs | 5,910 |
| Fragmentation bombs | 3,390 |
| Armor-piercing bombs | 1,930 |
| Incendiary bombs | 3,750 |
| Aircraft rockets | 1,810 |
| Total | 19,400 b/ |

a. Millimeter.    b. Rounded.

Table 8

Estimated Requirements for 1 Unit of Fire or the Equivalent
for Various Components of the Soviet Armed Forces

| Armed Force | Weight of 1 Unit of Fire (Short Tons) | Percent of Total |
|---|---|---|
| Army | 214,000 | 80.2 |
| Air Force (including naval aviation) | 19,400 | 7.3 |
| Coast defense artillery | 15,700 | 5.9 |
| Security troops | 12,300 | 4.6 |
| Naval fleet | 4,760 | 1.8 |
| Naval infantry | 475 | 0.2 |
| Total | 267,000 a/ | 100.0 |

a. Rounded.

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used for armor-piercing projectiles. Brass, composed of 70 percent copper and 30 percent zinc, is used in cartridge cases, primers, detonators, and fuses. Copper is used for rotating bands. Lead is used in bullets for small arms. Aluminum is a negligible material in ammunition. In US ammunition, some fuse parts are aluminum, but corresponding Soviet fuse parts are steel.

Inasmuch as the term component materials in this research aid refers to the actual amounts of materials in each round of ammunition, the weight of a complete round is the sum of the weights of the component materials of that round. The estimated breakdown of the component materials in individual rounds of Soviet ammunition is shown in Table 9.* All the ammunition and the corresponding tonnages which were discussed under the ammunition mixes have been redistributed into the following seven categories of ammunition: heavy artillery, medium artillery, light artillery, small arms, mortars and grenades, rockets and antitank weapons, and bombs and landmines. This redistribution was necessary because the mixes had to be derived from military T/O and E's, whereas an input study is more readily accomplished if the ammunition is grouped according to its structure, its component materials, and the processes involved in its production.

    2.  <u>Gross Inputs.</u>

Gross, or total, inputs of materials include those materials which are purchased by and flow through an ammunition plant in the processing of the final product, the finished ammunition. A part of these materials becomes component materials in the final product, and the remainder becomes scrap. The weights of the component materials shown in Table 9* were multiplied by certain factors to obtain the gross inputs. These factors represent the ratio of the weights of the gross inputs to the weights of the component materials. When the weights of the component materials are multiplied by the gross input factors, the resulting figures are the weights of the gross inputs. The difference between the weights of the gross inputs and the weights of the component materials represents metallic scrap. As noted in 3, below, a large portion of this scrap is recoverable. The gross input factors for production are as follows: 1.9 for cast iron, carbon steel, and alloy steel; 2.1 for brass and copper; and 1.02 for lead, propellants, and explosives.***

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   * Table 9 follows on p. 14.

   ** For the methodology used in the derivation of these factors, see Appendix A.

   *** Continued on p. 17.

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Table 9

Estimated Weights of Component Materials in 1 Unit of Fire or the Equivalent for Various Categories of Soviet Ammunition a/*

| Weapon | Cast Iron | Carbon Steel | Alloy Steel | Brass | Copper | Lead | Propellants | Explosives | Total (Short Tons) |
|---|---|---|---|---|---|---|---|---|---|
| **Heavy artillery** | | | | | | | | | |
| 14-inch naval gun | | | 191 | | 8.2 | | 64.2 | 9.6 | 273 |
| 12.6-inch naval gun | | | 157 | | 6.5 | | 46.2 | 7.85 | 218 |
| 12-inch naval gun | | | 1,420 | | 58.5 | | 403 | 68.2 | 1,950 |
| 10-inch naval gun | | | 90.4 | | 3.69 | | 24.6 | 4.3 | 123 |
| 203-mm b/ gun-howitzer | | 1,800 | | | 76.5 | | 332 | 347 | 2,550 |
| 7.1-inch naval gun | | | 1,060 | | 46.8 | | 374 | 79.6 | 1,560 |
| 152-mm gun-howitzer and self-propelled gun | | 2,690 | | 663 | 135 | | 582 | 437 | 4,510 |
| 152-mm howitzer | | 5,020 | | 366 | 215 | | 531 | 1,040 | 7,170 |
| 6-inch naval gun | | | 1,900 | 616 | 105 | | 700 | 175 | 3,500 |
| 5.9-inch naval gun | | | 21.5 | 7.18 | 1.22 | | 8.81 | 2.04 | 40.8 |
| Total heavy artillery | | 9,510 | 4,840 | 1,650 | 656 | | 3,070 | 2,170 | 21,900 |
| **Medium artillery** | | | | | | | | | |
| 5.1-inch naval gun | | 1,650 | 3,670 | 555 | 90 | | 537 | 165 | 3,000 |
| 5-inch naval gun | | 5.5 | | 1.84 | 0.30 | | 1.81 | 5.5 | 10 |
| 122-mm gun | | 3,670 | | 2,650 | 435 | | 2,350 | 1,730 | 14,500 |
| 122-mm howitzer | | 16,500 | | 1,660 | 732 | | 1,980 | 3,510 | 24,400 |
| 4.7-inch naval gun | | 60.5 | | 21.2 | 3.33 | | 19.8 | 6.22 | 111 |
| 4.1-inch naval gun | | 34.4 | | 12.0 | 1.85 | | 10.2 | 3.28 | 61.8 |
| 4-inch naval gun | | 8.07 | | 2.96 | 0.44 | | 2.34 | 0.79 | 14.6 |
| 100-mm gun | | 22,400 | | 15,000 | 1,570 | | 9,520 | 3,770 | 52,300 |
| 3.9-inch naval dual-purpose gun | | 1,490 | | 837 | 93.3 | | 541 | 152 | 3,110 |
| 3.5-inch naval gun | | 74.2 | | 30.2 | 4.17 | | 23.5 | 6.95 | 139 |
| 76.2- and 85-mm gun | | 12,500 | 12,500 | 8,660 | 1,350 | | 7,760 | 2,350 | 45,100 |
| 3-inch naval dual-purpose gun | | 811 | | 349 | 44.7 | | 229 | 56.6 | 1,490 |
| Total medium artillery | | 59,200 | 16,200 | 29,800 | 4,330 | | 23,000 | 11,800 | 144,000 |

* Footnotes for Table 9 follow on p. 16.

Table 9

Estimated Weights of Component Materials in 1 Unit of Fire
or the Equivalent for Various Categories of Soviet Ammunition
(Continued)

Short Tons

| Weapon | Cast Iron | Carbon Steel | Alloy Steel | Brass | Copper | Lead | Propellants | Explosives | Total |
|---|---|---|---|---|---|---|---|---|---|
| **Light artillery** | | | | | | | | | |
| 57-mm gun | | 2,930 | 2,930 | 3,900 | 357 | | 1,580 | 202 | 11,900 |
| 57-mm naval antiaircraft gun | | 1,520 | | 1,060 | 85.5 | | 94 | 91.2 | 2,850 |
| 45-mm naval gun | | 173 | | 59.3 | 7.74 | | 9.03 | 9.03 | 258 |
| 37-mm antiaircraft gun | | 1,580 | | 1,200 | 105 | | 523 | 102 | 3,510 |
| 37-mm aircraft gun | | 249 | | 197 | 16.8 | | 82.9 | 13.4 | 560 |
| 23-mm aircraft gun | | 957 | | 611 | 55.2 | | 162 | 55.2 | 1,840 |
| 20-mm antiaircraft gun | | 37.5 | | 32 | 2.6 | | 10.6 | 3.81 | 86.5 |
| Total light artillery | | 7,450 | 2,930 | 7,060 | 630 | | 2,460 | 477 | 21,000 |
| **Small arms** | | | | | | | | | |
| 12.7- and 14.5-mm machine gun | | 2,720 | | 5,980 | | 397 | 1,620 | | 12,400 |
| 7.62- and 9-mm small arms | | 6,500 | | 3,640 | | 5,720 | 2,540 | | 18,400 |
| Total small arms | | 9,220 | | 9,620 | | 6,120 | 4,160 | | 30,800 |
| **Mortars and grenades** | | | | | | | | | |
| 160- and 240-mm mortar | 2,795 | 3,400 | | | | | 131 | 708 | 4,240 |
| 120-mm mortar | 4,170 | 2,795 | | | | | 216 | 1,160 | 6,970 |
| 82-mm mortar | | 234 | | | | | 134 | 648 | 4,950 |
| Antitank grenades | | | | | | | | 200 | 434 |
| Hand grenades | 6,440 | | | | | | | 560 | 7,000 |
| Total mortars and grenades | 13,400 | 6,430 | | | | | 481 | 3,280 | 23,600 |

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Table 9

Estimated Weights of Component Materials in 1 Unit of Fire
or the Equivalent for Various Categories of Soviet Ammunition
(Continued)

Short Tons

| Weapon | Cast Iron | Carbon Steel | Alloy Steel | Brass | Copper | Lead | Propellants | Explosives | Total |
|---|---|---|---|---|---|---|---|---|---|
| Rockets and antitank projectiles | | | | | | | | | |
| 300-mm artillery rockets | | 249 | 124 | | | | 74 | 207 | 654 |
| 132-mm artillery and aircraft rockets | | 1,720 | 862 | | | | 595 | 381 | 3,560 |
| 107-mm recoilless projectiles | | 1,150 | 575 | | | | 497 | 380 | 2,600 |
| SPG-82 antitank projectiles | | 249 | 124 | | | | 108 | 82.2 | 563 |
| RPG-2 antitank projectiles | | 295 | 147 | | | | 127 | 97.2 | 666 |
| Total rockets and antitank projectiles | | 3,660 | 1,830 | | | | 1,400 | 1,150 | 8,040 |
| Bombs and land mines | | | | | | | | | |
| General-purpose and demolition bombs | | 2,660 | | | Negligible | | | 3,250 | 5,910 |
| Fragmentation bombs | | 3,050 | | | Negligible | | | 339 | 3,390 |
| Armor-piercing bombs | | 560 | | | Negligible | | | 1,370 | 1,930 |
| Incendiary bombs | | 2,250 | | | Negligible | | | 1,500 c/ | 3,750 |
| Antitank and antitransport mines | | 483 d/ | | | Negligible | | | 1,330 | 2,300 e/ |
| Total bombs and land mines | | 9,000 | | | Negligible | | | 7,790 | 17,300 e/ |
| Grand total | 13,400 | 104,500 | 25,800 | 48,100 | 7,310 | 6,120 | 34,600 | 26,700 | 267,000 e/ |

a. Because of rounding, figures may not add to totals shown.
b. Millimeter.
c. Mostly thermite.
d. Reduced 50 percent to allow for wooden mine cases.
e. Includes 483 tons allowed for wooden mine cases.

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The results obtained by applying the gross input factors to the estimated weights of the component materials in Table 9* are shown in Table 10.** These results are the gross inputs of materials required to produce 1 U/F for each of the 7 categories of ammunition and to produce an aggregate U/F for all 7 categories. Table 10 also shows the gross inputs required to produce 1,000 tons of any category of ammunition and 1,000 tons of the aggregate mix.

The gross inputs, expressed in terms of 1,000 tons of ammunition, serve as yardstick values in deriving estimates of materials for production of various categories and tonnages of Soviet ammunition. The gross inputs per 1,000 tons of ammunition may be applied to 1 or more of the categories of Soviet ammunition or to a general mix corresponding to the aggregate.

Not reflected in the material inputs are the practices of returning brass cartridge cases to the factories for re-use or remelting and the possible substitution of steel for brass in cartridge cases and of soft iron for copper in rotating bands. In view of these practices, the brass and copper inputs in the above values represent maximum figures.

3. Losses and Recovery of Scrap.

Metallic scrap derived from production is not entirely lost. Most of this scrap can be recovered and sold to the scrap metal industry. The unrecoverable portions, called remelt losses, are caused mainly by oxidation and scale. The small losses of lead, propellants, and explosives are not recoverable. Procedures similar to those used to obtain the weight of the gross inputs were used to obtain the totals of recoverable scrap. The weights of the component materials, shown in Table 9, were multiplied by the following factors for recovery of scrap: 0.72 for cast iron, carbon steel, and alloy steel, and 0.97 for brass and copper. The results, shown in Table 10, represent recoverable scrap.***

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Table 10

Estimated Gross Inputs of Materials Required to Produce 1 Unit of Fire or the Equivalent
for Various Categories of Soviet Ammunition and Quantities of Scrap Recoverable in Production

Short Tons

| Category of Weapon | Cast Iron a/* | Carbon Steel a/ | Alloy Steel a/ | Brass b/ | Copper b/ | Lead c/ | Propellants c/ | Explosives c/ | Total d/ |
|---|---|---|---|---|---|---|---|---|---|
| Heavy artillery | | | | | | | | | |
| Weight of component materials | | 9,510 | 4,840 | 1,650 | 656 | | 3,070 | 2,170 | 21,900 |
| Weight of gross inputs | | 18,100 | 9,200 | 3,460 | 1,380 | | 3,130 | 2,210 | 37,500 |
| Weight of recoverable scrap | | 6,850 | 3,480 | 1,600 | 636 | | | | 12,600 |
| Gross inputs per 1,000 tons of ammunition | | 826 | 420 | 158 | 63 | | 143 | 101 | 1,710 |
| Recoverable scrap per 1,000 tons of ammunition | | 313 | 159 | 73.1 | 29 | | | | 574 |
| Medium artillery | | | | | | | | | |
| Weight of component materials | | 59,200 | 16,200 | 29,800 | 4,330 | | 23,000 | 11,800 | 144,000 |
| Weight of gross inputs | | 112,000 | 30,800 | 62,600 | 9,100 | | 23,500 | 12,000 | 250,000 |
| Weight of recoverable scrap | | 42,600 | 11,700 | 28,900 | 4,200 | | | | 87,400 |
| Gross inputs per 1,000 tons of ammunition | | 778 | 214 | 435 | 63.2 | | 163 | 83.3 | 1,740 |
| Recoverable scrap per 1,000 tons of ammunition | | 296 | 81.2 | 201 | 29.2 | | | | 607 |
| Light artillery | | | | | | | | | |
| Weight of component materials | | 7,450 | 2,930 | 7,060 | 630 | | 2,460 | 477 | 21,000 |
| Weight of gross inputs | | 14,200 | 5,570 | 14,800 | 1,320 | | 2,510 | 487 | 38,900 |
| Weight of recoverable scrap | | 5,360 | 2,110 | 6,850 | 611 | | | | 14,900 |
| Gross inputs per 1,000 tons of ammunition | | 676 | 265 | 705 | 62.9 | | 120 | 23.2 | 1,850 |
| Recoverable scrap per 1,000 tons of ammunition | | 255 | 100 | 326 | 29.1 | | | | 710 |

* Footnotes for Table 10 follow on p. 20.

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Table 10

Estimated Gross Inputs of Materials Required to Produce 1 Unit of Fire or the Equivalent
for Various Categories of Soviet Ammunition and Quantities of Scrap Recoverable in Production
(Continued)

Short Tons

| Category of Weapon | Cast Iron a/ | Carbon Steel a/ | Alloy Steel a/ | Brass b/ | Copper b/ | Lead c/ | Propellants c/ | Explosives c/ | Total d/ |
|---|---|---|---|---|---|---|---|---|---|
| **Small arms** | | | | | | | | | |
| Weight of component materials | | 9,220 | | 9,620 | 1,690 | 6,120 | 4,160 | | 30,800 |
| Weight of gross inputs | | 17,500 | | 20,200 | 3,550 | 6,240 | 4,240 | | 51,700 |
| Weight of recoverable scrap | | 6,640 | | 9,330 | 1,640 | | | | 17,600 |
| Gross inputs per 1,000 tons of ammunition | | 568 | | 656 | 115 | 203 | 138 | | 1,680 |
| Recoverable scrap per 1,000 tons of ammunition | | 216 | | 303 | 53 | | | | 572 |
| **Mortars and grenades** | | | | | | | | | |
| Weight of component materials | 13,400 | 6,430 | | | | | 461 | 3,280 | 23,600 |
| Weight of gross inputs | 25,500 | 12,200 | | | | | 491 | 3,350 | 41,500 |
| Weight of recoverable scrap | 9,650 | 4,630 | | | | | | | 14,300 |
| Gross inputs per 1,000 tons of ammunition | 1,080 | 517 | | | | | 20.8 | 142 | 1,760 |
| Recoverable scrap per 1,000 tons of ammunition | 409 | 196 | | | | | | | 605 |
| **Rockets and antitank projectiles** | | | | | | | | | |
| Weight of component materials | | 3,660 | 1,830 | | | | 1,400 | 1,150 | 8,040 |
| Weight of gross inputs | | 6,950 | 3,480 | | | | 1,430 | 1,170 | 13,000 |
| Weight of recoverable scrap | | 2,640 | 1,320 | | | | | | 3,960 |
| Gross inputs per 1,000 tons of ammunition | | 864 | 433 | | | | 178 | 146 | 1,620 |
| Recoverable scrap per 1,000 tons of ammunition | | 328 | 164 | | | | | | 492 |

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Table 10

Estimated Gross Inputs of Materials Required to Produce 1 Unit of Fire or the Equivalent
for Various Categories of Soviet Ammunition and Quantities of Scrap Recoverable in Production
(Continued)

Short Tons

| Category of Weapon | Cast Iron a/ | Carbon Steel a/ | Alloy Steel a/ | Brass b/ | Copper b/ | Lead c/ | Propellants c/ | Explosives c/ | Total d/ |
|---|---|---|---|---|---|---|---|---|---|
| Bombs and land mines | | | | | | | | | |
| Weight of component materials | | 9,000 | | | | | | 7,790 | 17,300 e/ |
| Weight of gross inputs | | 17,100 | | | | | | 7,950 | 25,000 |
| Weight of recoverable scrap | | 6,480 | | | | | | | 6,480 |
| Gross inputs per 1,000 tons of ammunition | | 988 | | | | | | 460 | 1,450 |
| Recoverable scrap per 1,000 tons of ammunition | | 375 | | | | | | | 375 |
| Aggregate for all categories | | | | | | | | | |
| Total weight of component materials f/ | 13,400 | 104,000 | 25,800 | 48,100 | 7,310 | 6,120 | 34,600 | 26,700 | 267,000 e/ |
| Total weight of gross inputs f/ | 25,500 | 198,000 | 49,000 | 101,000 | 15,400 | 6,240 | 35,300 | 27,200 | 458,000 |
| Total weight of recoverable scrap f/ | 9,650 | 75,000 | 18,600 | 46,700 | 7,090 | | | | 157,000 |
| Gross inputs per 1,000 tons of aggregate ammunition mix g/ | 95.5 | 742 | 184 | 378 | 57.7 | 23.4 | 132 | 102 | 1,710 |
| Recoverable scrap per 1,000 tons of aggregate ammunition mix g/ | 36.1 | 281 | 69.7 | 175 | 26.6 | | | | 588 |

a. Derivation of gross inputs is based on a factor of 1.9; derivation of recoverable scrap, on a factor of 0.72.
b. Derivation of gross inputs is based on a factor of 2.1; derivation of recoverable scrap, on a factor of 0.97.
c. Derivation of gross inputs is based on a factor of 1.02.
d. Because of rounding, figures may not add to totals shown.
e. Total tonnage includes 463 tons allowed for wooden mine cases.
f. Sum of similar items in all categories.
g. Ratio (times 1,000) of sums of gross inputs to total tonnage (267,000 tons).

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B. Inputs of Services.

The services needed to produce ammunition are manpower, electric power, and fuels (coal, oil, and gas). The computations for the inputs of these services are based upon US data for similar services. The only data available, however, relate to the loading, assembling, and packing of ammunition at government installations. 12/ Private industry produces the metal parts for the ammunition but does not maintain records from which the desired data may be readily obtained. Many industrial plants in the USSR produce metal parts for ammunition and ship the parts to military ammunition depots for loading, assembling, and packing.

Table 11,* which is based on data obtained from 20 US sample pieces of ammunition,** shows the inputs of manpower and of electric power required for loading, assembling, and packing and the inputs of lumber and of steel required for packing 1 U/F of each of the 7 categories of Soviet ammunition, 1 U/F of the aggregate ammunition mix, and 1,000-ton units of the aggregate mix.***

Table 12**** shows the inputs of fuel required for loading assembling, and packing 1 U/F of Soviet ammunition. Because fuels may be used in the form of coal, fuel oil, or gas, the requirements for fuel are presented in terms of British thermal units (Btu)***** required per ton of ammunition; if any one of these fuels was used exclusively; and in terms of coal, fuel oil, or gas required per 1,000-ton units of ammunition.

The inputs for loading, assembling, and packing the ammunition listed in Tables 11 and 12 are only a fraction of the manpower, electric power, and fuels needed to produce complete rounds. 13/ Test calculations, based on very fragmentary data, indicated that the manpower required to produce metal parts for US 75-mm and 76-mm complete rounds is roughly between 8 and 12 times the manpower required for loading, assembling, and packing. Similar test calculations for US 75-mm, 76-mm, 90-mm, and 105-mm cartridge cases✝

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\*   Table 11 follows on p. 22.
\*\*   These samples were not in all cases included in the 26 US samples used to compute the material inputs.
\*\*\*   For the methodology, see Appendix A.
\*\*\*\*   Table 12 follows on p. 23.
\*\*\*\*\*   A standard measure of heat.
✝   Continued on p. 24.

Table 11

Estimated Inputs of Manpower and of Electric Power Required for Loading, Assembling, and Packing
and Inputs of Lumber and of Steel Required for Packing 1 Unit of Fire of Soviet Ammunition

| Category of Weapon | Weight of 1 Unit of Fire (Short Tons) | For Loading, Assembling, and Packing | | For Packing | |
|---|---|---|---|---|---|
| | | Manpower (Thousand Man-Hours) | Electric Power (Thousand Kilowatt-Hours) | Lumber (Thousand Board Feet) | Steel (Short Tons) |
| Heavy artillery | 21,900 | 93.7 | 479 | 2,740 | 637 |
| Medium artillery | 144,000 | 1,890 | 5,950 | 38,300 | 2,160 |
| Light artillery | 21,000 | 1,400 | 4,050 | 6,620 | 1,890 |
| Small arms | 30,800 | 4,200 | 32,600 | 7,020 | |
| Mortars and grenades | 23,600 | 659 | 7,070 | 8,010 | |
| Rockets and antitank projectiles | 8,040 | 171 | 1,120 | 1,230 | |
| Bombs and land mines | 17,300 | 104 | 1,100 | 819 a/ | 1,020 |
| Total b/ | 267,000 | 8,520 | 52,400 | 64,700 | 5,710 |
| Inputs per 1,000 short tons of ammunition (weighted average) | | 31.9 c/ | 196 | 242 | 21.4 |

a. 99 percent for land mines.
b. Aggregate ammunition mix. Because of rounding, figures may not add to totals shown.
c. 13.3 man-years.

Table 12

Estimated Inputs of Fuel Required for Loading, Assembling, and Packing 1 Unit of Fire
of Soviet Ammunition and the Equivalent Consumption in Terms of Soviet Coal, Fuel Oil, or Natural Gas

| Category of Weapon | Weight of 1 Unit of Fire (Short Tons) | Fuel Consumption (Btu a/ per Short Ton) | Coal Requirement (Short Tons) b/ | Fuel Oil Requirement (Short Tons) c/ | Gas Requirement (Short Tons) d/ |
|---|---|---|---|---|---|
| Heavy artillery | 21,900 | 375,000 | 393 | 228 | 206 |
| Medium artillery | 144,000 | 1,090,000 | 7,510 | 4,360 | 3,930 |
| Light artillery | 21,000 | 6,090,000 | 6,120 | 3,550 | 3,210 |
| Small arms | 30,800 | 2,130,000 | 3,140 | 1,820 | 1,640 |
| Mortars and grenades | 23,600 | 5,040,000 | 5,690 | 3,300 | 2,980 |
| Rockets and antitank projectiles | 8,040 | 3,930,000 | 1,510 | 878 | 792 |
| Bombs and land mines | 17,300 | 1,160,000 | 960 | 558 | 503 |
| Total e/ | 267,000 | 19,800,000 | 25,300 | 14,700 | 13,300 |
| Inputs per 1,000 short tons of ammunition (weighted average) | | | 94.8 | 55.1 | 49.8 |

a. British thermal units.
b. Assuming exclusive use of coal.
c. Assuming exclusive use of fuel oil.
d. Assuming exclusive use of natural gas.
e. Because of rounding, figures may not add to totals shown.

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indicated that the requirements for electric power to produce cartridge cases alone are several times the power required for loading, assembling, and packing the complete rounds. Moreover, the requirements for fuel to produce the cartridge cases are 8 to 14 times the requirements for loading, assembling, and packing the complete rounds.

C. Materials for Packing.

Materials used for packing, although inputs for production of ammunition, must be considered somewhat differently because the boxes and containers can be used more than once. In wartime the amount of re-use varies considerably. In peacetime the amount of re-use depends upon the relative quantities of ammunition used for training purposes or stockpiled, because stockpiling immobilizes the boxes and containers. No allowances were made in this research aid for the repeated use of boxes and containers, and the packing inputs therefore represent maximum consumption.*

Boxes for ammunition to be used by the ground forces are made of wood; containers for naval ammunition are made of steel and sometimes of aluminum. Because steel is used more frequently than aluminum, only steel is considered in this research aid. Heavy artillery projectiles, rockets, and bombs use little or no packing. The estimated quantities of lumber and steel required for packing Soviet ammunition are shown in Table 11.**

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\* For the methodology, see Appendix A.
\*\* P. 22, above.

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APPENDIX A

METHODOLOGY

1. Analysis of Soviet Ammunition.

Table 13* shows the method of calculation used to estimate the weight of 1 U/F for the Soviet security troops. The weight of 1 U/F was estimated by multiplying (a) the number of units used in each category of weapon by the number of rounds in 1 U/F and (b) the product of these calculations** by the weight of a representative round of ammunition. The estimated weight of 1 U/F for the Soviet Army*** and for the naval infantry**** were derived by the same method used for the Soviet security troops.

The number of antitank mines was estimated by allowing 1,500 mines to each of the 105 rifle divisions and 45 mechanized divisions and by allowing 1,000 mines to each of the 20 tank divisions, 20 artillery divisions, and 5 cavalry divisions. 14/ Hand grenades were allotted on the basis of four to each man, in accordance with the strength of the various divisions. 15/

The weight of a representative round as shown in column 5 of Table 13 means the weight of the round most commonly used for a particular weapon -- high-explosive, fragmentation-high-explosive, or armor-piercing. Illuminating, smoke, chemical, and leaflet-type rounds have not been considered, because they are of comparatively minor importance. 16/

The number of rounds for the guns of the Soviet naval fleet***** was computed by multiplying the estimated number of rounds carried by the various classes of vessels by the number of vessels in each class. 17/ Because information on the weights of Soviet naval ammunition was inadequate, it was necessary to make up a set of synthetic

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     *   Table 13 follows on p. 26.
    **   The total number of rounds in 1 U/F for 1 category of weapon.
   ***   See Table 2, p. 5, above.
  ****   See Table 6, p. 10, above.
 *****   See Table 4, p. 8, above.

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Table 13

Estimated Number of Rounds and Weight of 1 Unit of Fire for 400,000 Soviet Security Troops

| 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|
| Weapon | Unit | Number of Rounds in 1 U/F a/ for 1 Weapon | Total Number of Rounds for 1 Category of Weapon (Thousands) | Weight of a Representative Round (Pounds) | Weight of 1 U/F b/ (Short Tons) |
| T-34 tank with 85-mm c/ gun | 876 | 84 | 73.6 | 33.22 | 1,220 |
| Armored car d/ | 511 | | | | |
| Scout car d/ | 619 | | | | |
| 76-mm self-propelled gun | 330 | 90 | 30 | 18.08 | 271 |
| 85-mm antitank gun | 648 | 140 | 90.7 | 35 | 1,590 |
| 57-mm antitank gun | 1,820 | 200 | 364 | 14.33 | 2,610 |
| 120-mm mortar | 324 | 80 | 25.9 | 35.28 | 457 |
| 82-mm mortar | 3,100 | 120 | 372 | 6.94 | 1,290 |
| SPG-82 antitank projectiles | 660 | 42 | 27.7 | 7 | 97 |
| RPG-2 antitank projectiles | 9,630 | 9 | 86.7 | 3.52 | 153 |
| 12.7-mm antiaircraft machinegun | 1,310 | 6,000 | 7,860 | 2,160 e/ | 1,210 |
| 7.62-mm heavy machinegun | 6,170 f/ | 2,500 f/ | | | |
| 7.62-mm light machinegun | 14,000 | 800 | 55,300 g/ | 365 e/ | 1,440 |
| 7.62-mm rifle and carbine | 197,000 | 100 | | | |
| 7.62-mm submachinegun | 48,800 f/ | 300 f/ | 22,900 h/ | 170 | 278 |
| 7.62-mm pistol and revolver | 41,200 | 18 | | | |
| Antitank grenades | 86,700 | divisional basis | 86.7 | 2.4 | 104 |
| Hand grenades | 1,260,000 f/ | 4 per man | 1,310 i/ | 1.53 j/ | 1,000 |
| Land mines | 86,700 | divisional basis | 86.7 | 13 | 564 |
| Total | | | | | 12,300 k/ |

a. Unit of fire.
b. Column 4 times column 5.
c. Millimeter.
d. Included under machineguns.
e. Grains. Seven thousand grains equal 1 pound avoirdupois.
f. Does not include armament for armored vehicles.

g. Includes 9,030,000 rounds for machineguns mounted in armored vehicles.
h. Includes 7,570,000 rounds for submachineguns carried in armored vehicles.
i. Includes 48,200 grenades carried in armored vehicles.
j. Average.
k. Rounded.

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weights, using US naval ammunition as a base. 18/ These synthetic weights were then multiplied by the number of rounds for each type of gun, and the result was divided by 6 to obtain the equivalent of 1 U/F for the army.

On the basis of US naval experience, it was estimated that 50 percent of the Soviet shells of 6 inches or more in caliber would be high-capacity shells and 50 percent would be armor-piercing shells. 19/ All shells less than 6 inches in caliber were estimated to be high-capacity shells. 20/ Because the Soviet coast defense artillery* is composed of naval type guns and is operated by the navy, the ammunition allowance per barrel was based upon naval standards.

For weapons other than bombs, the estimated weight of 1 equivalent U/F for the Soviet Air Force** was obtained by the same method used for the Soviet security troops. The total number of rounds for the guns was estimated from plane armaments and ammunition loads. 21/ The total bomb load was calculated on the basis of the estimated bomb capacities of the planes. 22/

2. Computation of Component Materials in 1 Unit of Fire.

Table 14*** shows the estimated percentages of component materials in 1 U/F or the equivalent for various categories of Soviet ammunition. The percentages of Table 14 form the basis for the computations of Table 9.****

3. Derivation of Gross Input Factors for Component Materials.✦

Because there are no Soviet data upon which to compute input factors for Soviet production of ammunition, it was necessary to use data on US production. Twenty-six samples of US ammunition were selected -- mainly on the basis of the availability of information -- and their gross input factors were computed. 23/ The materials used in production of ammunition were grouped into ferrous materials (cast iron, carbon steel, and alloy steel); nonferrous materials (brass and✦✦

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    * See Table 5, p. 10, above.
   ** See Table 7, p. 12, above.
  *** Table 14 follows on p. 28.
 **** P. 14, above.
    ✦ Similar procedures were used to derive factors for recoverable scrap.
   ✦✦ Continued on p. 31.

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Table 14

Estimated Percentages of Component Materials in 1 Unit of Fire or the Equivalent
for Various Categories of Soviet Ammunition

| Weapon | Cast Iron | Carbon Steel a/* | Alloy Steel a/ | Brass b/ | Copper c/ | Lead | Propellants | Explosives |
|---|---|---|---|---|---|---|---|---|
| **Heavy artillery** | | | | | | | | |
| 14-inch naval gun | | | 70 | | 3 | | 23.5 | 3.5 |
| 12.6-inch naval gun | | | 72.2 | | 3 | | 21.2 | 3.6 |
| 12-inch naval gun | | | 72.8 | | 3 | | 20.7 | 3.5 |
| 10-inch naval gun | | | 73.5 | | 3 | | 20 | 3.5 |
| 203-mm d/ howitzer | | 70.4 | | | 3 | | 13 | 13.6 |
| 7.1-inch naval gun | | | 67.9 | | 3 | | 24 | 5.1 |
| 152-mm gun-howitzer and self-propelled gun | | 59.7 | | 14.7 | 3 | | 12.9 | 9.7 |
| 152-mm howitzer | | 70 | | 5.1 | 3 | | 7.4 | 14.5 |
| 6-inch naval gun | | | 54.4 | 17.6 | 3 | | 20 | 5 |
| 5.9-inch naval gun | | | 52.8 | 17.6 | 3 | | 21.6 | 5 |
| **Medium artillery** | | | | | | | | |
| 5.1-inch naval gun | | 55.1 | | 18.5 | 3 | | 17.9 | 5.5 |
| 5-inch naval gun | | 55 | | 18.4 | 3 | | 18.1 | 5.5 |
| 122-mm gun. | | 25.3 | 25.3 | 18.3 | 3 | | 16.2 | 11.9 |
| 122-mm howitzer | | 67.7 | | 6.8 | 3 | | 8.1 | 14.4 |
| 4.7-inch naval gun | | 54.5 | | 19.1 | 3 | | 17.8 | 5.6 |
| 4-inch naval gun | | 55.7 | | 19.5 | 3 | | 16.5 | 5.3 |
| 100-mm gun | | 55.3 | | 20.3 | 3 | | 16 | 5.4 |
| 3.9-inch naval dual-purpose gun | | 42.9 | | 28.7 | 3 | | 18.2 | 7.2 |
| 3.5-inch naval gun | | 47.8 | | 26.9 | 3 | | 17.4 | 4.9 |
| 76-2- and 85-mm gun | | 53.4 | | 21.7 | 3 | | 16.9 | 5 |
| | | 27.7 | 27.7 | 19.2 | 3 | | 17.2 | 5.2 |
| 3-inch naval dual-purpose gun | | 54.4 | | 23.4 | 3 | | 15.4 | 3.8 |

* Footnotes for Table 14 follow on p. 30.

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Table 14

Estimated Percentages of Component Materials in 1 Unit of Fire or the Equivalent
for Various Categories of Soviet Ammunition
(Continued)

| Weapon | Cast Iron | Carbon Steel a/ | Alloy Steel a/ | Brass b/ | Copper c/ | Lead | Propellants | Explosives |
|---|---|---|---|---|---|---|---|---|
| **Light artillery** | | | | | | | | |
| 57-mm antitank gun and antiaircraft gun | | 24.6 | 24.6 | 32.8 | 3 | | 13.3 | 1.7 |
| 57-mm naval antiaircraft gun | | 53.3 | | 37.2 | 3 | | 3.3 | 3.2 |
| 45-mm naval gun | | 67 | | 23 | 3 | | 3.5 | 3.5 |
| 37-mm antiaircraft gun | | 45.1 | | 34.1 | 3 | | 14.9 | 2.9 |
| 37-mm aircraft gun | | 44.5 | | 35.2 | 3 | | 14.8 | 2.4 |
| 23-mm aircraft gun | | 52 | | 33.2 | 3 | | 8.8 | 3 |
| 20-mm aircraft gun | | 43.4 | | 37 | 3 | | 12.2 | 4.4 |
| **Small arms** | | | | | | | | |
| 12.7- and 14.5-mm machinegun | | 21.9 | | 48.2 | 13.6 | 3.2 | 13.1 | |
| 7.62- and 9-mm small arms | | 35.3 e/ | | 19.8 | | 31.1 | 13.8 | |
| **Mortars and grenades** | | | | | | | | |
| 160- and 240-mm mortar f/ | | 80.2 | | | | | 3.1 | 16.7 |
| 120-mm mortar | 40.1 | 40.1 | | | | | 3.1 | 16.7 |
| 82-mm mortar | 84.2 | | | | | | 2.7 | 13.1 |
| Antitank grenades | | 54 | | | | | | 46 |
| Hand grenades | 92 | | | | | | | 8 |
| **Rockets and Antitank projectiles** | | | | | | | | |
| 300-mm artillery rockets | | 38 | 19 h/ | | | | 11.3 | 31.7 |
| 132-mm artillery and aircraft rockets | | 48.4 | 24.2 | | | | 16.7 | 10.7 |
| 107-mm recoilless projectiles h/ | | 44.2 | 22.1 | | | | 19.1 | 14.6 |
| SPG-82 antitank projectiles h/ | | 44.2 | 22.1 | | | | 19.1 | 14.6 |
| RPG-antitank projectiles h/ | | 44.2 | 22.1 | | | | 19.1 | 14.6 |

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Table 14

Estimated Percentages of Component Materials in 1 Unit of Fire or the Equivalent
for Various Categories of Soviet Ammunition
(Continued)

| Weapon | Cast Iron | Carbon Steel a/ | Alloy Steel a/ | Brass b/ | Copper c/ | Lead | Propellants | Explosives |
|---|---|---|---|---|---|---|---|---|
| Bombs and land mines | | | | | | | | |
| General-purpose and demolition bombs | | 45 | | | Negligible | | | 55 |
| Fragmentation bombs | | 90 | | | Negligible | | | 10 |
| Armor-piercing bombs | | 29 | | | Negligible | | | 71 |
| Incendiary bombs | | 60 | | | Negligible | | | 40 i/ |
| Antitank and antitransport mines | | 21 j/ | | | Negligible | | | 58 |

a. All US naval shells of about 6 inches and above are mostly alloy steel in US practice. Army and navy projectiles of most other type rounds are carbon steel with the exception of armor-piercing shells which are alloy steel.
b. Brass (70 percent copper and 30 percent zinc) is used in nearly all shell casings and primers.
c. Copper is used in nearly all rotating bands, constituting about 3 percent of the component weight of a round.
d. Millimeter.
e. Includes steel used in the estimated 50 percent of the cartridge cases made of steel. The other 50 percent of the cartridge cases are made of brass. Steel for cartridge cases represents 19.8 percent of the total weight of the ammunition used by this category of weapon.
f. The percentages are the same as those calculated for a 120-mm mortar.
g. About one-third of the steel is alloy used in the motor.
h. Percentages obtained from the US 2.36-inch antitank rocket.
i. Mostly incendiary material.
j. Reduced by one-half to allow for wooden cases.

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copper mill products); and a miscellaneous category including lead, propellants, and explosives. Changes were made in the US factors to allow for known differences between the Soviet and the US ammunition being compared. The factors thus obtained were applied to the estimated weights of the various component materials to derive the gross input factors for Soviet ammunition.

4. Derivation of Service Inputs.

The input data for manpower, electric power, and fuels were available for only 20 US sample items of ammunition, which were not in all cases the same US items used to compute the inputs of materials. A new alignment of the items of Soviet ammunition with the US samples was necessary before the US data could be properly weighted.

Table 15* lists the 20 US sample items of ammunition employed and the computed quantities of the nearest equivalent Soviet ammunition in 1 U/F. Because the data are not homogeneous as were the data for the inputs of materials, it was necessary to derive a weighted input factor for each category rather than a single factor for the entire aggregate. The weighted input factors were derived by multiplying US input requirements per ton of each U/F by the quanity of the nearest equivalent Soviet ammunition in 1 U/F.

The manpower and electric power required to load, assemble, and pack the respective U/F mix were then recapitulated in Table 11.** The figures for fuel, however, needed further treatment to reduce them to a common denominator -- British thermal units -- and to re-expand them in terms of Soviet coal, fuel oil, and gas.

The inputs of fuel were reduced to British thermal units by multiplying the weighted averages listed in Table 15 by the average heat value of the US oil or gas. The average heat value of the oil was taken at 138,000 Btu per gallon and the gas at 1,000 Btu per cubic foot. 24/ These calculations resulted in the following heat requirements to load, assemble, and pack 1 ton of each category of weapon***:

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Table 15

Estimated Soviet Inputs for Services in Production of Ammunition a/*

| US Weapon | Short Tons of Nearest Equivalent Soviet Ammunition in 1 Unit of Fire | Manpower | | Electric Power | | Fuel Oil | | Gas | |
|---|---|---|---|---|---|---|---|---|---|
| | | US Man-Hours per Short Ton | Total Soviet Man-Hours b/ | US Kilowatt-Hours per Short Ton | Total Soviet Kilowatt-Hours c/ | US Gallons per Short Ton | Total Soviet Gallons d/ | US Cubic Feet per Short Ton | Total Soviet Cubic Feet e/ |
| 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| Heavy artillery | | | | | | | | | |
| 240-mm f/ howitzer | 2,560 | 6.91 | 17,700 | 33.4 | 85,500 | 5.97 | 15,300 | | |
| 8-inch howitzer | 2,550 | 6.88 | 17,500 | 21.7 | 55,300 | 3.88 | 9,890 | | |
| 155-mm gun | 16,800 | 3.48 | 58,500 | 20.1 | 338,000 | 2.05 | 34,400 | | |
| Total | 21,900 | | 93,700 | | 479,000 | | 59,600 | | |
| Weighted average | | 4.28 g/ | | 21.9 h/ | | 2.72 i/ | | | |
| Medium artillery | | | | | | | | | |
| 105-mm howitzer | 24,400 | 5.6 | 137,000 | 42.9 | 1,050,000 | 8.2 | 200,000 | | |
| 90-mm gun | 118,000 | 14.7 | 1,730,000 | 40.6 | 4,790,000 | 7.76 | 916,000 | | |
| 76-mm gun | 1,490 | 14.6 | 21,800 | 75.4 | 112,000 | 15.4 | 22,900 | | |
| Total | 144,000 | | 1,890,000 | | 5,950,000 | | 1,140,000 | | |
| Weighted average | | 13.1 g/ | | 41.3 h/ | | 7.9 i/ | | | |
| Light artillery | | | | | | | | | |
| 57-mm recoilless rifle | 15,000 | 36.7 | 550,000 | 253 | 3,800,000 | 51.7 | 776,000 | | |
| 20-mm gun | 6,010 | 142 | 853,000 | 42.2 | 254,000 | 25 | 150,000 | | |
| Total | 21,000 | | 1,400,000 | | 4,050,000 | | 926,000 | | |
| Weighted average | | 66.7 g/ | | 193 h/ | | 44.1 i/ | | | |

* Footnotes for Table 15 follow on p. 34.

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Table 15

Estimated Soviet Inputs for Services in Production of Ammunition a/

(Continued)

| 1 | 2 | Manpower | | Electric Power | | Fuel Oil | | Gas | |
|---|---|---|---|---|---|---|---|---|---|
| | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| US Weapon | Short Tons of Nearest Equivalent Soviet Ammunition in 1 Unit of Fire | US Man-Hours per Short Ton | Total Soviet Man-Hours b/ | US Kilowatt-Hours per Short Ton | Total Soviet Kilowatt-Hours c/ | US Gallons per Short Ton | Total Soviet Gallons d/ | US Cubic Feet per Short Ton | Total Soviet Cubic Feet e/ |
| Small arms | | | | | | | | | |
| 50 caliber | 12,400 | 77.3 | 959,000 | 406 | 5,030,000 | | | 963 | 11,900,000 |
| 30 caliber | 18,400 | 176 | 3,240,000 | 1,500 | 27,600,000 | | | 2,920 | 53,700,000 |
| Total | 30,800 | | 4,200,000 | | 32,600,000 | | | | 65,600,000 |
| Weighted average | | 136 g/ | | 1,060 h/ | | | | 2,130 | |
| Mortars and grenades | | | | | | | | | |
| 4.2-inch mortar | 11,200 | 14.1 | 158,000 | 76.2 | 853,000 | 12.4 | 139,000 | | |
| 81-mm mortar | 4,950 | 18.7 | 92,600 | 219 | 1,080,000 | 44.7 | 221,000 | | |
| Rifle grenade | 434 | N.A. | | 428 | 186,000 | 42 | 18,200 | | |
| Hand grenade | 7,000 | 54.9 | 408,000 i/ | 707 | 4,950,000 | 69.2 | 484,000 | | |
| Total | 23,600 | | 659,000 | | 7,070,000 | | 862,000 | | |
| Weighted average | | 27.9 g/ | | 300 h/ | | 36.5 i/ | | | |
| Rockets and antitank projectiles | | | | | | | | | |
| 4.5-inch rocket | 6,810 | 16.5 | 112,000 | 120 | 817,000 | 24.5 | 167,000 | | |
| 3.5-inch rocket | 1,230 | 47.8 | 58,800 | 246 | 303,000 | 50.1 | 61,600 | | |
| Total | 8,040 | | 171,000 | | 1,120,000 | | 229,000 | | |
| Weighted average | | 21.3 g/ | | 139 h/ | | 28.5 i/ | | | |

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Table 15

Estimated Soviet Inputs for Services in Production of Ammunition a/
(Continued)

| 1 | 2 | Manpower | | Electric Power | | Fuel Oil | | Gas | |
|---|---|---|---|---|---|---|---|---|---|
| | | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| US Weapon | Short Tons of Nearest Equivalent Soviet Ammunition in 1 Unit of Fire | US Man-Hours per Short Ton | Total Soviet Man-Hours b/ | US Kilowatt-Hours per Short Ton | Total Soviet Kilowatt-Hours c/ | US Gallons per Short Ton | Total Soviet Gallons d/ | US Cubic Feet per Short Ton | Total Soviet Cubic Feet e/ |
| Bombs and land mines | | | | | | | | | |
| 100-lb k/ general-purpose bomb | 7,490 | 7.72 | 57,800 | 72 | 539,000 | 12.9 | 96,600 | | |
| 750-lb demolition bomb | 7,490 | 2.46 | 18,400 | 33.1 | 248,000 | 5.9 | 44,200 | | |
| Antitank mine | 2,300 | 11.9 | 27,400 | 138 | 317,000 | 2.24 | 5,150 | | |
| Total | 17,300 | | 104,000 | | 1,100,000 | | 146,000 | | |
| Weighted average | | 6.01 g/ | | 63.6 h/ | | 8.44 i/ | | | |

a. Soviet ammunition tonnages are weighted by US service input figures per short ton. Input figures are for loading, assembling, and packing only. Figures may not add to totals shown because of rounding.
b. Column 2 times column 3.
c. Column 2 times column 5.
d. Column 2 times column 7.
e. Column 2 times column 9.
f. Millimeter.
g. Total of column 4 divided by total of column 2.
h. Total of column 6 divided by total of column 2.
i. Total of column 8 divided by total of column 2.
j. Rifle grenade tonnage and hand grenade tonnage combined.
k. Pound.

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| Category | British Thermal Units (Thousands) |
|---|---|
| Heavy artillery | 375 |
| Medium artillery | 1,090 |
| Light artillery | 6,090 |
| Small arms | 2,130 |
| Mortars and grenades | 5,040 |
| Rockets and antitank projectiles | 3,930 |
| Bombs and land mines | 1,160 |

To re-expand these heat values in terms of Soviet fuels, it was necessary to know the average heat values of Soviet fuels. The following values were estimated: coal, 10,450 Btu per pound, or 20.9 million Btu per ton; fuel oil, 18,000 Btu per pound or 36 million Btu per ton; and gas, at 39.9 million Btu per ton.

With these figures it was possible to compute in tons the Soviet coal, fuel oil, and gas required to load, assemble, and pack 1 U/F in each category of ammunition. For example, the computation for heavy artillery is as follows:

Heavy artillery tonnage times heat required per ton equals total heat required: 21,900 times 375,000 equals 8,210 million Btu.

$$\text{Coal:} \quad \frac{8{,}210 \text{ million Btu}}{20.9 \text{ million } \dfrac{\text{Btu}}{\text{ton}}} = 393 \text{ tons coal.}$$

$$\text{Fuel oil:} \quad \frac{8{,}210 \text{ million Btu}}{36 \text{ million } \dfrac{\text{Btu}}{\text{ton}}} = 228 \text{ tons fuel oil.}$$

$$\text{Gas:} \quad \frac{8{,}210 \text{ million Btu}}{39.9 \text{ million } \dfrac{\text{Btu}}{\text{ton}}} = 206 \text{ tons gas.}$$

The other categories were similarly computed and the results were recapitulated in Table 12.*

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\* P. 23, above.

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## 5. Wood and Steel for Packaging.

Data on the size and/or the gross and net weights of Soviet Army ammunition boxes were available. 25/ From these data it was possible to compute the number of board-feet per ton required by each type of Soviet round which was packaged in wood. In each case the number of board-feet per ton was then multiplied by the tonnage of the pertinent round to obtain the total number of board-feet required for that round. These subtotal figures were added for each category to obtain the total amount of wood in board-feet (properly weighted by the tonnage of each round). These weighted totals for each category are shown in Table 11.* In computing the requirement for wood per round, 15 percent was allowed for sawdust and waste. This scrap can be salvaged and used for manufacturing pressboard and other similar products, but no attempt to compute the amount of scrap recovered was made.

Because no data were available on Soviet naval containers, which use most of the steel consumed in packaging ammunition, synthetic weights for powder cans and shell containers were computed from a curve based upon US naval cans and containers. The number of pounds of steel per ton of the pertinent rounds was computed, multiplied by the tonnage of that round, and totaled by category to obtain the weighted requirements for packing steel per category. These category totals are shown in Table 11. In computing the requirement for steel per round, a gross input factor of 1.9 for ferrous metals was used.**

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* P. 22, above.
** See III, A, 2, p. 13, above.

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APPENDIX B

GAPS IN INTELLIGENCE

The ideal data upon which to build a report on input factors would come from the files of the producing plants.  Because such data obviously are not available for Soviet ammunition plants, an alternative is to use analogical methods.  It is in the area of analogical data that a practical gap exists.  In the US, data are available on the manpower, electric power, and fuels required for loading, assembling, and packing ammunition because that work is done mostly in governmental installations.  The metal parts, however, are made principally by private contractors who also produce other items.  These contractors do not keep their records in a form in which the above data are easily available -- such data usually being lumped under "factory expense" which also includes insurance, maintenance, and the like.  Moreover, there is a reluctance on the part of the contractors to divulge the necessary information.

There is also a need for information which will enable analysts to discount and to modify US data to suit Soviet industrial conditions. Comparisons then might be made for the two countries in regard to the productivity of labor, to the use of manpower versus electric power, and to waste and spoilage.

Other gaps concern data on Soviet naval ammunition and logistical information on supplies of ammunition and stockpiling practices of the Soviet Navy and Air Force.

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APPENDIX C


SOURCE REFERENCES


Almost all the data used to compute the ammunition mixes are from formal publications or contributions of the US armed services. Most of the data from which the input factors were computed and the data on service inputs and prices came from the War Mobilization Planning Division of the Ordnance Ammunition Command, US Army, Joliet, Illinois, and may be assumed to be reliable. Some of the data on inputs came from a 1947 publication of the Civilian Production Authority and are believed to be fairly reliable, although possibly a little high.

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Evaluations, following the classification entry and designated "Eval.," have the following significance:

| Source of Information | Information |
|---|---|
| Doc. - Documentary | 1 - Confirmed by other sources |
| A - Completely reliable | 2 - Probably true |
| B - Usually reliable | 3 - Possibly true |
| C - Fairly reliable | 4 - Doubtful |
| D - Not usually reliable | 5 - Probably false |
| E - Not reliable | 6 - Cannot be judged |
| F - Cannot be judged | |

"Documentary" refers to original documents of foreign governments and organizations; copies or translations of such documents by a staff officer; or information extracted from such documents by a staff officer, all of which may carry the field evaluation "Documentary."

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Evaluations not otherwise designated are those appearing on the cited document; those designated "RR" are by the author of this report. No "RR" evaluation is given when the author agrees with the evaluation on the cited document.

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